Before Hearing Commissioners at Christchurch

under:	the Resource Management Act 1991
in the matter of:	Submissions on the Proposed Hurunui and Waiau River Regional Plan
between:	**Fonterra Co-operative Group Limited** *Submitter*
and:	**Dairy NZ** *Submitter*
and:	**Canterbury Regional Council** *Local Authority*

Statement of evidence of **David Graeme McCall** (Farm management) for Fonterra Co-operative Group Limited and Dairy NZ

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STATEMENT OF EVIDENCE OF DAVID GRAEME MCCALL FOR FONTERRA CO-OPERATIVE GROUP LIMITED AND DAIRY NZ

INTRODUCTION

1 My full name is David Graeme McCall.

2 I hold the degrees of Doctor of Philosophy in Agricultural Economics and Farm Management (Massey University, 1984) and Bachelor of Agricultural Science Hons I (University of Canterbury, 1977). In my PhD I developed a computer model to describe and study pastoral grazing systems by simulation. The model was one of only two whole farm models internationally at the time. This original model is the foundation of a number of models used in New Zealand and internationally, including the Farmax model.

3 I am a member of the New Zealand Institute of Agricultural Science and the New Zealand Institute of Primary Industry Management.

4 I am employed by DairyNZ Limited as a senior manager, leading the Development and Extension team. This team leads farmer change initiatives for the dairy industry, many of which are explained in more detail in Mr James Ryan's evidence. I have been with DairyNZ and its predecessor Dexcel for 5.5 years.

5 In my early science career from 1978 to 1998 I was employed by MAF and then AgResearch. I studied farm systems both in the field and via modelling. This included sheep/beef, goat and dairy farm systems. Key achievements included development and technology transfer of the Stockpol decision support model which was subsequently branded Farmax. Farmax predicts the production and economic effects of changes to a farm system. My work also included the modelling and research, in collaboration with AgResearch soil scientists, on the original Overseer (then named Outlook) soil fertility decision support model.

6 I also established and led AgResearch's first modelling and decision support teams in the 1990's. I was internationally recognised for work in decision support modelling in 1991 at a conference in Texas, in the US. I have authored or co-authored 120 scientific papers and articles on both modelling and the study of farm systems.

7 From 1999 through 2006 I worked in business development for AgResearch and then Celentis (2002), a biotech company.

8 I have read the Environment Court's Code of Conduct for Expert Witnesses, and I agree to comply with it. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise, except where I state I am relying on what I have been told by another person. I

have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

9 I am familiar with the aspects of the Proposed Hurunui and Waiau River Regional Plan (*the Proposed Plan*) relevant to my evidence to which these proceedings relate.

SCOPE OF EVIDENCE

10 This evidence addresses one proposition supporting the Proposed Plan that existing Hurunui dairy farms can reduce nitrogen leaching in order to create the headroom for anticipated irrigation development in the catchment to maintain the current nitrogen footprint employing good practice and reducing waste.

11 I calculate the level of reduction in nitrogen leaching that existing farmers could be expected to achieve by moving to systems that give the most efficient and economic use of nitrogen inputs. Through calculations made by Ms Shirley Hayward, and repeated in this evidence, I present what this means in terms of additional land that can be irrigated while maintaining current catchment losses of nitrogen and phosphorus.

12 My evidence addresses why it is not efficient or viable for existing or new farms to operate systems that apply high levels of capital and operating cost in order to mitigate nitrogen losses to the so-called Tier 1 + Tier 2 levels described in Mr Norton's s42A evidence for the Council and described in Brown et al (2011).

13 My evidence addresses the control of phosphorus loss in conjunction with nitrogen, to create headroom for irrigation development from existing and new dairy farms.

14 I also touch on the potential use of nitrogen discharge limits for individual farms and issues with the use of the Overseer model to set absolute N loss levels for regulations.

SUMMARY OF EVIDENCE

15 In my opinion, headroom for land use development can be achieved by driving the efficiency of resource use, including nitrogen use, in existing dairy farm businesses to its economic optimum[1] for each farm and so improve nitrogen conversion efficiency[2] and reduce

[1] The economic optimum for a farm is found by maximising the efficiency of resource use on that farm (e.g. application of fertiliser, use of feed, number of animals and use of different irrigation systems) by eliminating waste. In determining the economic optimum for a farm the level of resource use is progressively constrained below its current level until profit is maximised. The technically efficient resource use corresponds to the resource-use that achieves maximum profit.

[2] Nitrogen conversion efficiency is a measure of the percentage of nitrogen input to a farm that is captured in product (either meat or milk, e.g. 30%). The greater the conversion efficiency the greater the percentage of nitrogen that is exported as product.

nitrogen waste (nitrogen surplus) and thus leaching. I describe this as making a farm "technically efficient".

16 Calculations that I present show the amount of nitrogen leaching-loss headroom that could be created by achieving 100% technical efficiency across all existing Hurunui dairy farms adds up to 13%. When this is added to efficiencies from the conversion of border dyke irrigation to spray irrigation on the 7% of properties still using border dyke in the Hurunui catchment (Mr Mike Hide discusses this in his evidence), then headroom in the order of 17% can be achieved.

17 Practically, this level may be impaired because of complexity of farm decision making which occurs in an uncertain, climatically variable environment. However, in my view, a figure of 17% over all farms should be considered a reasonable target. The nitrogen leaching savings will vary between individual farms from 0% up to 66% (Lilburne et al 2010) in the case of a border-dyke irrigated farm.

18 Calculations by Ms Hayward show that the amount of nitrogen load reduction in the Hurunui River from a 17% reduction in loss across dairy land in the catchment is in the order of 91 tonnes. The additional land that could be irrigated for new dairy farms using this headroom is in the order of 4,500 to 6,679 ha (Ms Shirley Hayward's evidence) given that new dairy farms adopt the same farm system intensity and nitrogen use efficient practices presented in this evidence.

19 In the lower Hurunui catchment where phosphorus rather than nitrogen is considered to be the limiting nutrient affecting periphyton growth, Ms Hayward is of the view that existing nitrogen levels in the Hurunui River mainstem can be increased without compromising water quality values, provided phosphorus levels are kept at the same level or reduced.

20 Therefore, Ms Hayward calculates that headroom for up to a maximum of an additional 32,000 ha development can be achieved. This will be undertaken by a combination of reducing nitrogen waste on existing farm businesses through improved technical efficiency, converting border dyke irrigation to spray irrigation, reducing phosphorus losses from all farms and allowing some additional nitrogen levels in the river.

21 Following this approach, measures will be needed to ensure that phosphorus losses are maintained at current levels within the catchment. I recommend that Audited Self Management Schemes contain particular reference to the need to control phosphorus loss

22 In my view, measures to contain phosphorus losses to maintain water quality values and support additional irrigation development

are realistic and economically achievable for existing and new dairy farms. With the exception of replacing border-dyke irrigation, which is common for nitrogen and phosphorus mitigation, the mitigations to reduce phosphorus loss are different to those to reduce nitrogen, and represent a one-off cost to the farmer. While not my direct expertise, McDowell et al's (2009) figure 5 shows that measures being taken on dairy farms are reducing phosphorus losses by minimising surface run-off of sediment and effluent through appropriately designed effluent systems, riparian planting, denying stock access to waterways, and control of run-off from stock-tracks and bridges. However, McDowell et al (2009) shows that while phosphorus losses can be reduced through these measures, intensification has still led to increases in nitrogen loss.

23 I also address background reports that suggest that existing dairy farms can reduce existing nitrogen losses by 50% in order to create headroom for irrigation development. In my opinion, it is unrealistic to expect to reduce nitrogen leaching by an average of 50% across all dairy farms to create headroom for development, as suggested in the Tier 1 + Tier 2 approach described in Mr Norton's evidence and Brown et al (2011). There is a lower limit to the amount that total nitrogen input (atmospheric plus synthetic) can be reduced while still maintaining productive grass species. This means that farms with already very low inputs are unlikely to be able to reduce their nitrogen losses further.

24 In addition, in my opinion, for other farms that do not have very low existing inputs, the fixed cost of investing in and operating capital intensive options, such as stock-housing, to mitigate losses beyond those at efficient nitrogen use levels (Tier 2) will significantly impact the future viability of farm businesses.

25 In my opinion, the best overall outcomes are likely to be achieved where farmers move to systems that operate at moderate intensity and maximise profit by maximising the efficiency of use of nitrogen and other inputs rather than operating overly intensive systems and applying mitigations, such as stock-housing, to reduce the resulting nitrogen losses. In my view, such outcomes can be achieved through the proposed industry-led Audited Self Management Schemes discussed by Mr Ryan in his evidence, subject to refining the objectives for these schemes as recommended by Mr Willis.

26 Finally, while not part of the existing plan, I agree with the response of Ms White that more work is required on methods before attempting to set nutrient discharge allowances for each farm. I set out consistency issues with the use of models (including Overseer) in setting absolute limits for regulations across farms. As the science behind a model improves and is represented in new versions of a model, then absolute predictions (e.g. of nitrogen leaching) will change.

27 In my opinion, the appropriate use of Overseer under the Proposed Plan regime is to support the analysis of the relative effects of options for a farm to control leaching loss within that farm. This can occur by using a constant set of base assumptions for that farm and if necessary, adjusting the base for any change in the model.

HEADROOM FROM EXISTING FARMS

Technical efficiency

28 As it stands, the only way to get nutrient loss headroom for additional irrigation development under the HWRRP is from a reduction in losses by existing farmers. A background report (Brown et al, 2011) and the evidence of Mr Norton suggests that for nitrogen losses, a 50% average reduction can be achieved by existing farmers using Tier 1 + Tier 2 mitigations.

29 Mitigation by the methods suggested (such as investment in stock-housing and feeding systems) can lead to intensification and will incur significant cost on existing businesses thus reducing their long-term economic viability, as shown in a later section of this evidence.

30 In my opinion, the alternative approach to create headroom from existing businesses is to operate moderate intensity farming and drive the efficiency of nitrogen input and other resource use to its economic optimum. This will reduce waste in nitrogen use and hence reduce nitrogen surplus while retaining the competitiveness of the businesses for the long term. In my opinion, only if a business sought to intensify creating additional nitrogen surpluses above its current technical efficiency point would further mitigation be part of the solution. In this situation the economic cost of mitigation would be a business choice by the farmer and presumably would need to be justified by the additional profit they could achieve by intensifying.

31 In order to provide evidence for this approach and to calculate headroom potential from high nitrogen use efficiency, data were gathered from 32 farms in the Hurunui catchment. These 32 farms were processed through Overseer version 5.4.10 and separated into four quadrants (shown in Figure 1) based on their estimated leaching loss and nitrogen conversion efficiency (*NCE*). The data in Figure 1 shows that, across the Hurunui catchment dairy farms, as the efficiency of nitrogen use increases (NCE), the nitrogen leaching loss decreases.

32 From the 32 farms, four farms were chosen to calculate the opportunity to reduce nitrogen leaching by optimising technical efficiency and thus nitrogen conversion efficiency. These farms approximately mapped one to each of the four quadrants in Figure 1.

33 The four farms were analysed through the GSL linear programming (*LP*) model.[3] The GSL model was developed, and is operated, by Mr Barrie Ridler a former senior lecturer in farm management at Massey University. The model calculates the maximum profit for a farm for a given level of input-resource use. Resulting leaching loss predictions were calculated on Overseer version 5.4.10.

34 The reduction in nitrogen leaching by optimising nitrogen and other resource use efficiency to its economic optimum was 21%, 0%, 23% and 12% respectively for each farm modelled.

35 The results presented in Figure 2 show the detail for each of the four farms where change in profit is plotted against nitrogen leaching loss as resource inputs to the farm are progressively constrained below current levels.

36 Results show the ability for positive outcomes from technical efficiency gains giving increased profitability and reduced nitrogen leaching loss on three of the four farms. The positive outcome occurs because the farms are not currently operating at their economic optimum for nitrogen input and other resource use efficiency.

37 Extrapolation of these results to all farms in the catchment yielded estimated potential headroom of 13%. Extrapolation was done by assuming the results for each modelled farm applied to all other farms in the same quadrant in Figure 1.

Change in irrigation systems

38 In addition to improved nitrogen conversion efficiency, farms with border-dyke irrigation infrastructure can have high levels of nitrogen leaching loss associated with the inability to control excess soil water drainage (Lilburne et al, 2010). The Canterbury nitrate leaching look-up tables, appendix 1 (Lilburne et al (2010) suggest that converting border-dyke irrigation infrastructure to spray irrigation can reduce nitrogen leaching loss by 66%.

39 When the conversion of border dyke irrigation to spray irrigation on the 7% of properties still using border dyke in the catchment (see Mr Michael Hide's evidence's) is factored in, then headroom in the order of 17% is achievable from existing farms.

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3 The GSL model was chosen over Farmax (which was used for the calculations presented in Brown et al 2011, and of which the author of this evidence was a developer). This was because GSL is more efficient at finding optimal resource use allocations due to it being an optimising, rather than a simulation model. With simulation models (such as Farmax) the definition of optimal resource use requires the user to iterate their way to an optimum solution. This iteration is time consuming, not always full-proof and optima may be missed. Predictions from Farmax and GSL are very close, given similar resource inputs. This is shown in Table 1 where predicted outputs for the current configuration for three of the farms which had previously been loaded into Farmax by another user, were compared with predictions by GSL. It means that the only significant difference between the models is in the model structure (optimising – GSL, versus simulation - Farmax).

40 That 17% is achievable assumes that all existing farms can and do move to their optimal technical efficiency. While this is a reasonable expectation over time, the time taken for individual farmers to adapt will depend on their management capability. Farm management decision making is made complex by uncertain and variable elements of climate, interest rate and milk pay-out, all of which challenge management capability.

Constraining resource use below that for technical efficiency

41 Theoretically, greater gains in leaching loss could be achieved by requiring farmers to reduce nitrogen leaching losses below those at the technically efficient level, and preserve only the opportunity to achieve current profitability (see Figure 2).

42 By the method used above in paragraphs 34 to 37, but applying this argument and recalculating headroom based on preserving the opportunity only to achieve current profit, this would lift headroom by a further 3% from the catchment.

43 In my opinion, the issue with this argument is that it eliminates all opportunity for farmers to sustain their future businesses in the face of rising costs of production due to inflation in inputs. These costs can-not just be passed on to export customers. Farm businesses are sustained through time by capturing benefit from gains in technical efficiency.

44 In the last five years New Zealand's internal farm input-cost inflation index has risen at 3.6% pa, compared to CPI at 2.8% pa and compared to the long run export milk price increase of 2.2% pa (Department of Statistics; DairyNZ Economics Group). Where farm input-cost inflation runs ahead of milk price increase, farmer margins shrink through time (-1.4% pa in last 5 years), unless farmers have the scope to make technical efficiency gains that allow them to achieve an economic optimum.

45 Constraining resource inputs to sub-optimal levels will adversely impact the ability of farmers to sustain their businesses in the future. Long-run competitiveness of dairy farming and its contribution to New Zealanders will thus be impacted with likely flow-on effects to communities. Of every dollar earned by dairy farmers $0.92 of income benefit ends up in the pockets of other New Zealanders (NZIER Study 2010).[4]

MANAGEMENT OF PHOSPHORUS

46 I understand from the water science evidence (Ms Hayward) that phosphorous and not nitrogen is the limiting nutrient for periphyton growth in the lower Hurunui River catchment. This situation creates

[4] Based on 4.440 million New Zealanders and 1.3b kg milk solids production.

a need to avoid increased phosphorus losses as part of irrigation development to protect present water-way values.

47 While not my direct expertise, McDowell et al's (2009) figure 5 shows that phosphorus losses on-farm can be managed independently to nitrogen loss. McDowell et al's (2009) figure 5 shows that despite intensification of dairy farms, measures being taken to reduce phosphorus losses have resulted in a decline in phosphorus losses over the last 20 years while nitrogen losses have increased. As Mr Ryan has stated, there has been significant growth of dairy farming in Canterbury over the last ten to twenty years.

48 Measures taken to reduce phosphorus loss have involved minimising the surface run-off of sediment and effluent through appropriately designed effluent systems, riparian planting, denying stock access to waterways, and the control of run-off from stock-tracks and bridges. The further avoidance of phosphorus and faecal losses is achievable for dairying through initiatives currently being implemented by the industry (Mr Michael Hide's evidence). These include proper control of effluent through appropriately designed effluent systems and the provision of knowledge, training and support to farmers (by Fonterra Sustainable Dairy Advisers, DairyNZ and accredited rural professionals) to apply effluent correctly to land so that it does not run-off. This is backed up by supply conditions agreed to by all dairy companies through DCANZ.

49 In addition, the dairy industry is implementing a programme to ensure that farmer riparian planting obligations and obligations to deny stock access to waterways and control run-off from races and water crossings are met through a Clean Streams Accord II. (Mr Ryan's evidence). These measures are designed to stop sediment plus faecal material, and therefore phosphorus, entering waterways.

50 Other initiatives that control phosphorus loss relate to minimising sediment losses associated with cropping practices by ensuring that crops are not grazed close to waterways, and the upgrade of border dyke irrigation infrastructure to spray irrigation, thus reducing the loss of sediment and faecal matter into water-ways via "wipe-off" water.

51 Mitigations to minimise phosphorus losses require one-off expenses by farmers unlike many nitrogen mitigations which have an on-going effect on operating costs. In my opinion, measures to contain phosphorus losses to maintain water quality values and support additional irrigation development are economically achievable for existing and new dairy farms.

FEASIBILITY OF 50% NITROGEN-LOSS REDUCTION ACROSS THE CATCHMENT

Biological feasibility of the 50% reduction

52 I have reviewed the report of Brown et al (2011) and the detailed appendices to this report described by Campbell et al (2011). The report is based on Overseer and Farmax model analyses that claim there is scope for existing dairy businesses in the Hurunui catchment to reduce nitrogen leaching loss by 50%. I do not support this claim.

53 My first concern with the report (hereto referred to as the Campbell report) is the biological feasibility of the 50% reduction assertion based on extrapolation from one theoretical farm scenario to the entire catchment. From regional benchmarking data (see Mr James Ryan's evidence where he discusses Audited Nutrient Management) we know there is considerable variability in the level of current nitrogen leaching loss between farms across a region. The 50% assumption means that either all farms can reduce nitrogen leaching by the 50% achieved on the theoretical modelled farm, or if not, farms with above average leaching loss can reduce by significantly more than 50%.

54 The theoretical farm scenario modelled by Campbell et al (2011) had a high leaching loss (47 kg N / ha) for this catchment. Comparatively, the extent to which farms already leaching low amounts can further reduce nitrogen leaching is limited by a lower feasible limit for nitrogen leaching under productive pasture. That is, to sustain high-quality grass species required for productive pastures a minimum level of nitrogen input either from fixed (clover) or synthetic (fertiliser) sources is needed (Clark and Harris 1995). This applies to all developed pastures, not just dairy pastures.

55 The Overseer model relies on the user to ensure that there are feasible levels of nitrogen input to sustain pasture grasses. It does not constrain the user from creating scenarios with unfeasibly low nitrogen inputs for long term grass species sustainability. Hence, nitrogen leaching predictions from the Overseer model may make it appear that very low levels of nitrogen leaching are possible, when in reality they are not and have not occurred in the past.

56 The lower biological limit for input to sustain grass species in developed pastures is around 200 kg N/ha/year from either fixed or synthetic sources (Ledgard et al 2009). In Overseer this minimum level of nitrogen input invokes a leaching loss of between 19 and 26 kg N/ha/year on the Hurunui catchment farm study described in paragraph 31. The variation (19 to 26) is due to soil type and rainfall. This infers a minimum level of nitrogen leaching associated with sustaining productive grass species. Historically, nitrogen

inputs to New Zealand pastures were sustained by high levels of clover in the pasture supported by phosphate fertilisers (Ledgard et al 2009). More recently with the incursion of the clover root weevil pest, nitrogen fertiliser has increased in importance to provide this input.

57 The implication is that farms at or near a nitrogen leaching loss of 19 to 26 kg N /ha /year (depending on soil type) will have very little room to further reduce nitrogen leaching.

Attainability across different farm types

58 The second possibility in reducing overall leaching loss by 50% is that some farms with above average leaching losses are able to reduce leaching by substantially more than 50%, thus allowing an overall reduction by all existing businesses of 50%.

59 The ability for farms leaching more than average to decrease leaching by more than 50% depends on the factors driving current nitrogen leaching loss. Where this includes soil type as shown by the Campbell et al (2011) examples, then Overseer predictions provided by Campbell et al (2011) show that the ability to reduce leaching by more than 50% on these farms is also limited.

60 Hence from the viewpoint of sustaining the productive grass species required for dairy farming the feasibility of a 50% reduction in leaching by existing businesses looks highly questionable across a population of farms such as the Hurunui River catchment.

Campbell et al recommendations do not report full economic implications of mitigations

61 The second area where I consider the Campbell et al (2011) report contains assessment gaps relates to the flow on effects of nitrogen mitigation costs on the long term viability of existing farm businesses and therefore rural community viability.[5] In my opinion, even if a 50% reduction in nitrogen leaching loss is considered technically feasible, these broader implications need to be factored in.

62 In my opinion, it is reasonable to require that the inefficient use of nitrogen is eliminated to create headroom for further development. Equally in my opinion, it is not desirable to reduce the economic viability of existing nitrogen-efficient businesses, with the consequent flow-on effects to rural communities,[6] by using costly mitigations to drive nitrogen loss levels down further in order to develop more farms that are also likely to struggle to maintain viability.

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5 See the Taylor McClintock McCrostie 2003 study referred to in Mr Ryan's evidence and Mr Butcher's evidence for more detail on this matter.

6 As above.

63 The Campbell et al (2011) analysis does not consider the effect of reductions in cash operating-surplus, caused by the cost of mitigations, on the ability of farms to meet their other cash commitments. All mitigation options as described by Campbell et al (2011) reduce cash operating-surplus despite the report showing an advantage to cash operating-surplus from the use of DCDs.

64 My view is that the DCD analysis in Campbell et al (2011) is inaccurate and therefore further exaggerates the reported economic costs of mitigations.

65 In the Campbell et al (2011) study, pasture growth responses to DCD are assumed at 4%, 5.5% and 7% annually. This gives a predicted net benefit in cash operating-surplus in this study of $100 to $161 /ha /year over and above DCD costs (Campbell et al Table A1.3). A more realistic assessment is a net loss of cash operating-surplus of $115 / ha / year from two applications of DCD.

66 Claimed pasture responses to DCD of between 5% and 10% of annual production (1000 – 2000 kg additional pasture DM / ha / year) arose from controlled plot trials where the DCD was carefully placed directly on a urine patch at the optimum time. The recent national trials reported by Gillingham et al (2012) where DCD was applied in paddocks with the vagaries of variable timing of application relative to optimum, and variability in spreading, resulted in an average response of only 3% of pasture growth from the period of June through October. This response amounts to additional pasture of about 200 kg DM/ha/year on a highly productive irrigated Canterbury dairy farm.

67 A summary of the effects of the mitigations in Campbell et al on cash operating-surplus (Campbell et al Table A1.5), but reworked for DCD net cost as above, is reproduced in Table 2. The next section of this evidence shows the effects of these results on the ability of farms to buffer both milk price and interest rate volatility, ultimately affecting long term dairy farm business viability in the catchment.

68 The key issue with the Campbell et al analysis is that it does not position the increase in costs required for mitigations within the context of all cash needs to sustain the farm businesses. Operating-surpluses are required to service interest commitments on debt and the living expenses of the owner. After these commitments, cash operating-surplus is used to repay debt and for reinvestment in farm infrastructure.

Potential impacts of 50% nitrogen-loss reduction across the catchment

69 Features of dairy farming in Canterbury are the level of debt held owing to historical investment and the need for businesses to be able to withstand volatile returns.

70 The average debt liability on Canterbury farms stands at $26,594 / ha (DairyNZ Economic Survey 2010-11). This reflects investment required for dairy farm development. At current farm interest rates, which are in the order of 7% pa, this translates to an average liability of $1,862/ha / year in interest costs. This compares to the figure of $1,990 / ha cash operating-surplus for the farm in the Campbell et al (2011) analysis (Campbell et al, Table A1.3). Clearly this leaves little room for these businesses to buffer extra cost at the pay-out of $6.10 / kg milk-solids assumed by Campbell et al (2011). In fact it is just sufficient to breakeven when an allowance is made for personal drawings of $40,000 pa. This breakeven scenario is supported by Mr Stuart Ford in his October 2012 presentation to the Selwyn-Waihora zone committee.

71 When viewed across all farms in Canterbury, Figure 3 shows a plot of the range of operating and interest costs on the 73 farms that were part of DairyNZ's latest economic survey. This survey was for the financial year ending (FYE) 31 May 2011 (DairyNZ Economic Survey 2010-11). The costs are expressed as dollars per kg milk solids (*MS*).

72 The breakeven milk price for any farm is defined as the price that meets both cash-operating costs and interest costs. In my opinion, serious consequences for mainstream farm viability occur when more than 25% of farms operate below breakeven milk pay-out more than one year in five.

73 The solid line in Figure 4 shows that the farm income where 25% of the 73 farms will operate at a deficit for cash-operating and interest commitments. This point is a farm income of $6/kg MS (solid line on Figure 4). The 25% of farms operating at a deficit, and hence increasing debt, are those to the right of the solid line.

74 As a reference point, farm income of $6/kg MS equates to a milk pay-out of $5.70 /kg MS, the remaining income is from stock sales. Also as a reference point the current pay-out is $5.75 / kg MS. This is the second time in the last 5 years that the pay-out has dropped to or below this breakeven level; the last time was in 2008/09.

75 Analysis of the Campbell et al (2011) scenarios in their Table A1.5 and presented in Table 2 shows that they add $0.31 / kg MS to total costs. At our pay-out of $5.75/kg MS; this means an additional 15% of farms would be below breakeven pay-out; 40% in total. That is, all farms to the right of the dashed line in Figure 4.

76 In my opinion, it would not be wise to threaten the viability of a large number of existing farm businesses, in order to create headroom for investment in the development of new businesses that will equally be affected because of debt levels.

APPROPRIATE USE OF OVERSEER MODEL

77 While I understand it is outside the scope of the present plan change process, I note the evidence of Mr Brown and Mr Norton refers to the allocation of "nutrient discharge allowances" at farm level as a potentially preferred approach to integrate audited self-management into a regulatory framework. While the idea merits consideration, the method of how this would be done needs to be well worked though before any decision is made, particularly as it might relate to using a model such as Overseer.

78 Overseer as a model is a useful tool to support decision making about ways of reducing nitrogen leaching losses. In my opinion, taking the next step and using the model to give an absolute number for allowable loss to be allocated and applied across farms is problematic. This is illustrated with respect to Overseer and nitrogen leaching losses.

79 Between the time that analyses for this evidence were conducted and the writing of this document, a new version of the Overseer model was released; version 6.0. Re-analysis on Overseer 6 of the case study farms provided a good example of the issue.

80 Predicted nitrogen leaching losses on all farms increased when using Overseer version 6.0 compared to Overseer version 5.4.10 (Table 3). Despite the increase in predicted nitrogen leaching loss from land, clearly it will not have changed the physical nitrogen loads in the Hurunui River system. What the Overseer model can be used to determine is not the absolute losses but the relative contributions of farms to that loss.

81 In my opinion, an example of how the Overseer model can be used in context is to model base conditions on each farm using a standard protocol. Then, for any change on a given farm, an Overseer analysis can determine the relative effects of that change on predicted nitrogen leaching loss from the base situation.

82 This approach better allows for situations where nitrogen leaching predictions change because of changes made to the model, as knowledge improves, by allowing the scaling of the base predictions for a farm. It also allows for the consideration of options available to individual farms to be taken into account in setting any target for leaching loss reduction for that farm.

CONCLUSIONS

83 In my opinion, it is reasonable to expect that existing farmers create nitrogen loss headroom for the further development of the Hurunui catchment by improving the technical efficiency of their nitrogen use and by converting irrigation infrastructure from border-dyke to spray irrigation.

84 The calculations of Ms Hayward show that the headroom that can be created is 91 tonne of nitrogen load from a 17% reduction of nitrogen loss across the catchment's existing dairy farms. This is enough to irrigate an additional 4,500 to 6,679 ha of land for new technically efficient dairy farms.

85 In my opinion, it is also reasonable to expect that all farmers in the catchment take action to reduce their phosphorus losses to ensure that phosphorus loads in the Hurunui River do not increase above existing loads and so preserve water quality values.

86 In my opinion, it is unrealistic for existing farmers to create nitrogen loss headroom of 50% by using costly (Tier 2) mitigations as suggested by some reports. From information I present, it is unlikely that such a reduction across all dairy farms would be biologically feasible without taking some farms out of dairy. Even if it were feasible, the high additional fixed cost of mitigation would threaten the viability of 40% of existing businesses.

87 Finally, in the lower Hurunui River catchment which I understand is considered to be phosphorus rather than nitrogen limited, the calculations of Ms Hayward show that up to a maximum of 32,000 ha of land could potentially be developed as irrigated land by a combination of constaining phosphorus loads as described above, creating 17% nitrogen loss headroom across existing farms and allowing for a reasonable amount of additional nitrogen load from new farms.

Dr David McCall

12 October 2012

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Table 1. Comparison of Farmax and GSL predictions for current performance of Farms 1, 3 and 4. Note Farm 2 was not modelled on Farmax

Farm	**Farm 1**		**Farm 3**		**Farm 4**	
Model	**Farmax**	**GSL**	**Farmax**	**GSL**	**Farmax**	**GSL**
Farm area (ha)	141	141	297	297	190	190
Cow numbers	503	503	1087	1080	620	620
Milksolids to factory (kg ms)	232,831	232,487	541,640	541,413	266,604	266,630
Production per cow (kg ms / cow)	463	462	498	501	430	430
Hay/silage fed (tonnes)	228	212	210	200	41	40
PKE fed (tonnes)	89	90	0	0	0	0
Other feeds fed (tonnes) Straw Maize silage Molasses Wheat	 43 0 0 0	 40 0 0 0	 75 207 44 814	 45 200 45 920	 40 0 0 357 Barley	 40 0 0 336 Barley
Silage conserved (tonnes)	132	72	60	125	40	0
Nitrogen fertiliser (kgN/ha)	320	315	257	256	232	232
Expenses ($/ha)	$7,042	$7,068	$7,573	$7,586	$5,347	$5,410
Crop area (ha)	0	0	0	0	15	15
Cow graze-off	All 63 days	All 65 days	All 63 days	All 65 days	370 63 days	350 65 days
Replacement Graze-off	From weaning	From weaning	From weaning	From weaning	From weaning	From weaning

Table 2. Additional fixed costs imposed by the mitigations proposed in Campbell et al (2010); reworked for the DCD component.

Item	$/ha
Operating profit pre mitigation costs as per Table A1.3	2790
Loss of revenue from over-estimated DCD assumption	-256
DCD application cost	-210
Shelter cost as per Campbell et al assumptions	-626
Net operating profit after mitigation cost	1698
Less base operating profit	(1990)
Net cost of mitigations	-292

Table 3. Comparison of nitrogen leaching loss predictions for Farms 1, 2 and 3 for Overseer version 5.4.10 and Overseer 6. Note Farm-4, not able to be reliably modelled on Overseer 6 at the time of preparing this evidence.

Farm Number	Overseer Version 5.4.10	Overseer Version 6
1	43	74
2	28	43
3	35	41

Figure 1: Plot of Overseer version 5.4.10 predicted nitrogen leaching (kg N/ha/yr) and nitrogen conversion efficiency (NCE %) for 32 Hurunui catchment dairy farms (2011 year); average lines shown in blue.

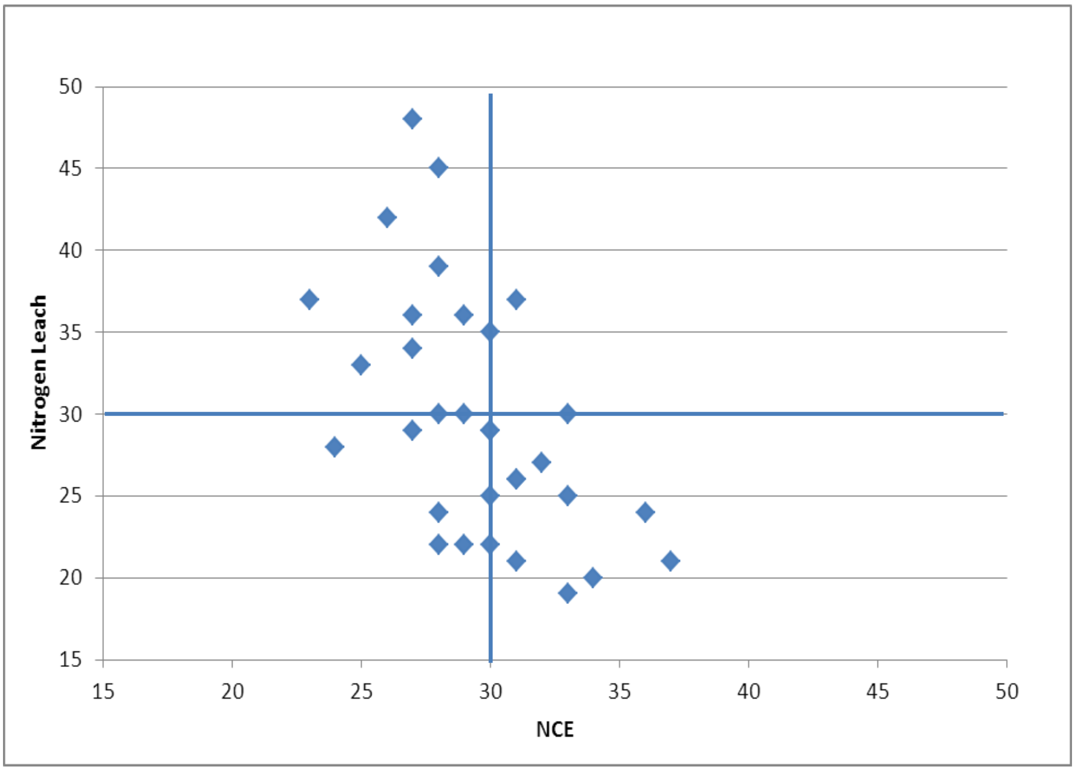

Figure 2: Response functions for nitrogen leaching loss and operating-cash surplus for four Hurunui-catchment farms where responses are driven by level of nitrogen fertiliser use.

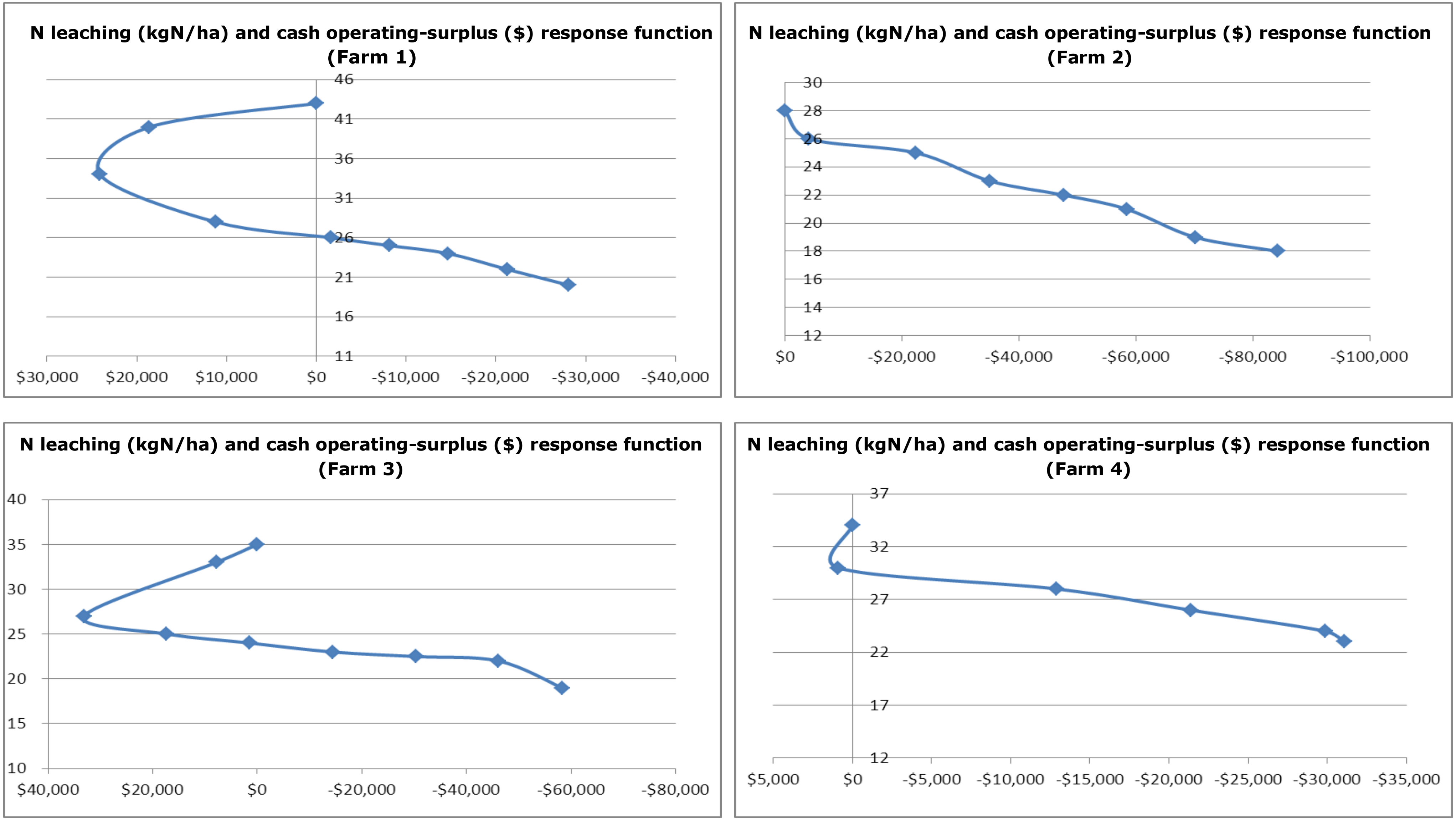

Figure 3: Interest costs and farm working expenses for 73 Canterbury dairy farms in the financial year ending 2010/11. Source: DairyNZ economic survey 2010/11.

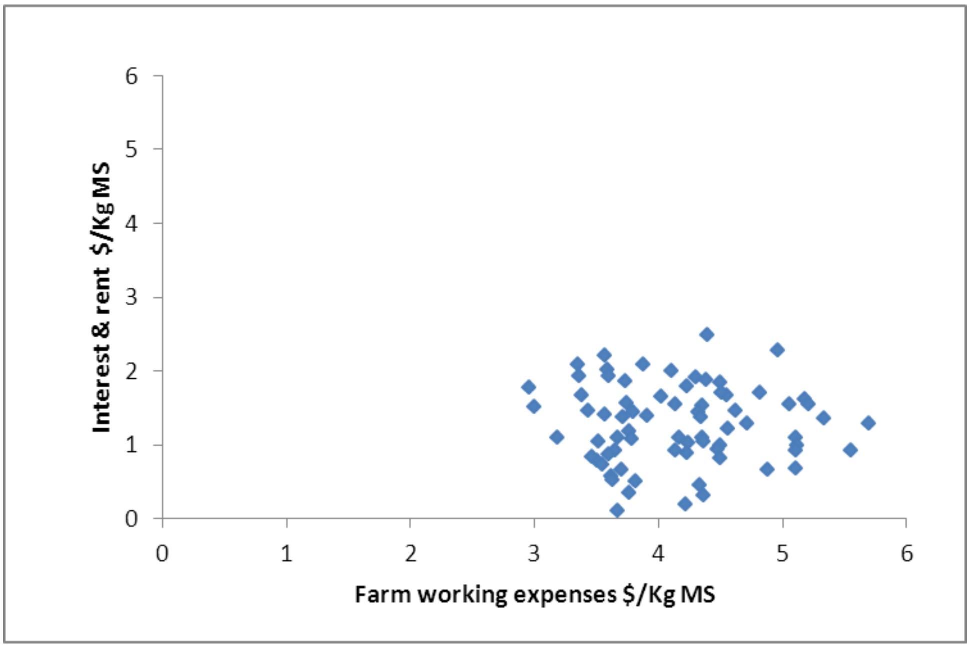

Figure 4: Farm income in $ / kg milk solids at which 25% of Canterbury farms would have insufficient cash income to meet interest costs and farm working expenses (red line; $6 / kg milk solids) and the effect of an additional $0.30 / kg milk solids cash costs on the percentage of farms (40%) with insufficient cash income to meet interest costs and farm working expenses (dashed red line)